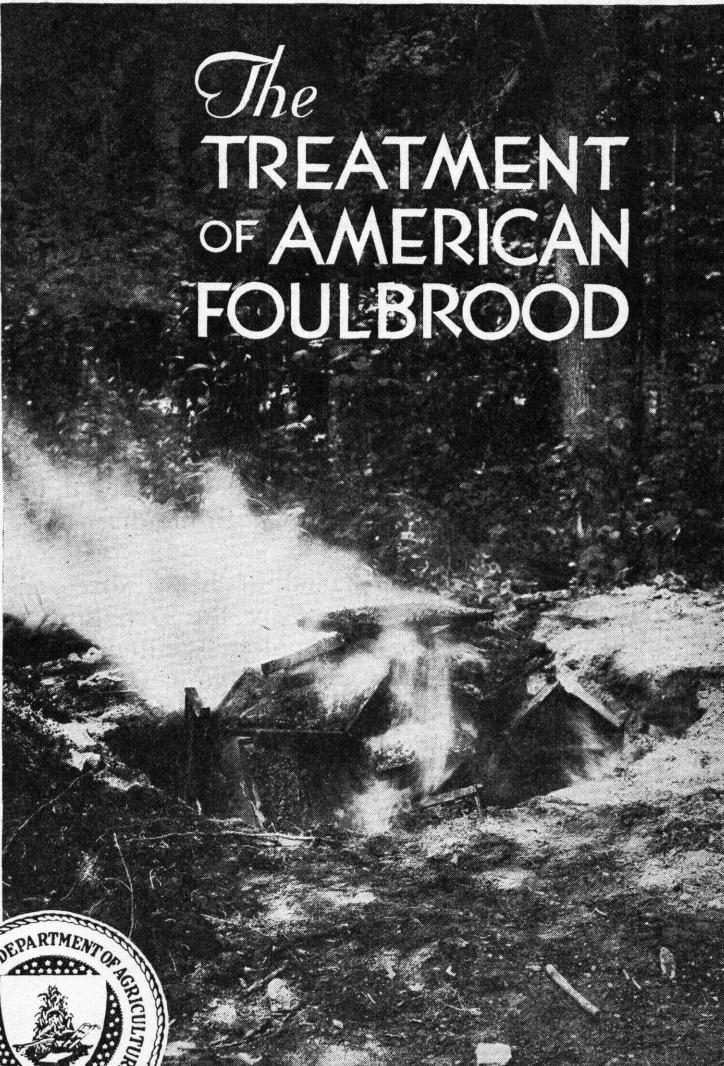


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U. S. DEPARTMENT OF  
AGRICULTURE  
FARMERS' BULLETIN No. 1713

*The*  
**TREATMENT  
OF AMERICAN  
FOULBROOD**



**A**MERICAN FOULBROOD is a disease of the brood of bees which causes serious losses to beekeepers. Its occurrence is practically world-wide, it attacks all races of bees, and strong colonies are as liable to infection as weak ones.

It is important that the beekeeper recognize the symptoms of the disease and be familiar with the manner in which it is spread, in order that he may take precautions to keep it out of his apiary and to prevent it from spreading from one colony to another in case any of his colonies become infected. He should also know how to treat the disease in the most effective way. Such information is given in this bulletin. It is impossible to manipulate colonies so that they cannot contract the disease, but much worry and financial loss can be avoided by dealing promptly and effectively with the disease as soon as it appears.

Samples of brood suspected of being diseased are diagnosed free of charge by the Division of Bee Culture, Bureau of Entomology, United States Department of Agriculture, Washington, D.C.

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Washington, D.C.

Issued October 1933

# THE TREATMENT OF AMERICAN FOULBROOD

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AMERICAN FOULBROOD is a disease of the brood of bees which causes series losses to beekeepers. Not only does it take a heavy toll in the actual destruction of colonies and increase the cost of operating an apiary, but, what is perhaps of equal importance, the presence of disease in an apiary, or in the vicinity of one, causes such mental anxiety to some beekeepers that it unquestionably prevents them from succeeding in the bee industry.

The disease is practically world-wide in its distribution and is of common occurrence in the United States. All races of bees are susceptible. There have been statements in the beekeeping literature that lead one to believe that the brood of certain strains of bees is immune, but there is no evidence upon which to base this assumption. There may be various strains of the disease, differing in virulence, and individual colonies may react differently. Not enough variation has yet been detected, however, to warrant giving such suspected cases special treatment. Worker larvae are particularly susceptible to the disease, although queen and drone larvae are occasionally affected. Adult bees are immune to it.

## CAUSE OF THE DISEASE

American foulbrood is caused by a species of spore-bearing bacteria known as *Bacillus larvæ*. The living honeybee larva is its only known host and the disease is transmitted primarily by means of the spores. The bees that work within the hive become contaminated with these spores in attempting to remove the diseased brood, and carry them from one cell to another. Once the disease has spread generally throughout the brood nest, the bees cease trying to remove the dead brood, and it accumulates until the colony dies owing to the absence of emerging bees.

In performing such tasks as feeding the larvae, building the cells, ripening the nectar, and transferring it from one part of the hive to another, the bees may contaminate not only honey that is in the brood nest, but also that in the supers above the queen excluder. This does not mean, however, that all the honey in the brood nest or supers necessarily becomes contaminated.

Spores may come in contact with larvae of any age, but the larvae rarely die until they have developed to the point where they lie lengthwise in the cells or the cells are being sealed preparatory to transformation to pupae. During the early coiled stages the sugar content of the larva is usually high and, since the germ of American foulbrood will not grow in highly concentrated sugar or honey, it is only after much of the body sugar has been utilized that the spores can develop. Underfed larvae have a low sugar content, and in contact with such larvae the spores are able to germinate and to kill the larvae while they are still coiled.

The spores of American foulbrood are invisible to the naked eye, and they are extremely resistant to sunlight, drying, heat, and commonly used chemical disinfectants. The maximum time that the spores retain their virulence has not been determined, but they are known to remain alive for years in honey and brood combs.

#### SPREAD OF THE DISEASE

It has always been considered that the disease is spread from colony to colony most commonly by the robbing of hives containing disease-weakened colonies or bees that have died of American foulbrood, by bees from healthy colonies. Robbing unquestionably scatters American foulbrood. A disease-weakened colony does not defend itself well; therefore it is possible for robber bees from healthy colonies to help themselves to contaminated honey. On the other hand, the beekeeper himself often unwittingly spreads the disease within an apiary when he moves combs of brood and honey from one hive to another, or unites weak colonies, which may be diseased, with strong, healthy ones. These are probably the most common means of spread. The disease may also be carried from one colony to another when bees enter the wrong hive, a practice generally referred to as drifting.

The dissemination of the disease beyond the range of flight of the bee can be accounted for by the transportation of infected material, including honey, into a disease-free area, where it is later made accessible to healthy bees. Experimental evidence indicates that the commercial shipment of honey is not such an important means of spread as many persons suppose. The sale of used, contaminated equipment is, however, one of the principal avenues through which this disease is spread from one locality to another.

A beekeeper who does not know anything about American foulbrood, or how to check its spread in his apiary, will not be able to maintain his colonies with profit if they become weakened by the disease. Finding this to be the case, he may sell his empty hives, combs, and other accessories, perhaps to another beekeeper who knows no more about the bee diseases than he does. Purchasers of

used beekeeping equipment should make sure that it is free from disease material. Some States wisely restrict the sale of used bee-keeping equipment to that which is known to be uncontaminated.

### SYMPTOMS

In the apiary American foulbrood can be detected only by the presence of brood remains. The spores of the disease organism can be recovered and identified only by bacteriological technic.

The disease may be recognized by the sunken and perforated cappings and the isolated sealed cells in the midst of recently emerged brood. The dead larvae have a melted-down appearance and are usually extended lengthwise in the cells (fig. 1). Occasionally the bees die while in the coiled stage, and in this condition the brood may resemble that dead of European foulbrood. Dead larvae are slightly yellowish or dirty white in color at first, but become chocolate brown or black upon further decay. Shortly after death of the larvae, and until the contents of the cells become too thick, the brood remains can be drawn out with a toothpick into fine silklike threads, and are quite ropy and gluelike. Upon drying, the brood remains, called scales (fig. 1, F, G), become tough or brittle and adhere so tightly to the floor and base of the cells that the bees cannot remove them. The scales are very thin and in old, dark brood combs are easily overlooked.

Pupae that die of the disease undergo similar changes in color and consistency and in the final formation of a scale (fig. 2). Occasionally the tongue of a dead pupa adheres to the roof of the cell. This is a significant, but not an infallible, symptom.

Bees remove many of the cappings from cells containing dead brood, and this makes it appear that the larvae or pupae died before being sealed.

American foulbrood has a characteristic odor, which is pronounced when the disease is in an advanced stage.

Although adult bees are not attacked, loss of brood causes an infected colony to become gradually weaker, and usually to die during the second year of the disease.

The constancy and the uniformity of the symptoms characterize this disease more than does any one symptom. Isolated sealed, sunken, or perforated cells in the midst of healthy emerging brood should be examined whenever disease is suspected. It is not difficult to make a reliable diagnosis in the apiary except perhaps when only 1 or 2 recently dead larvae or pupae are present. In such cases a portion of the comb containing the suspected brood should be sent to a competent inspector. In the meantime the entrance of the suspected hive should be contracted and the colony left undisturbed until the nature of the trouble has been determined.

### OTHER BROOD DISEASES SOMETIMES MISTAKEN FOR AMERICAN FOULBROOD

Many colonies have been destroyed or treated in the erroneous belief that they were infected with American foulbrood. On the other hand, the disease has been spread when American foulbrood

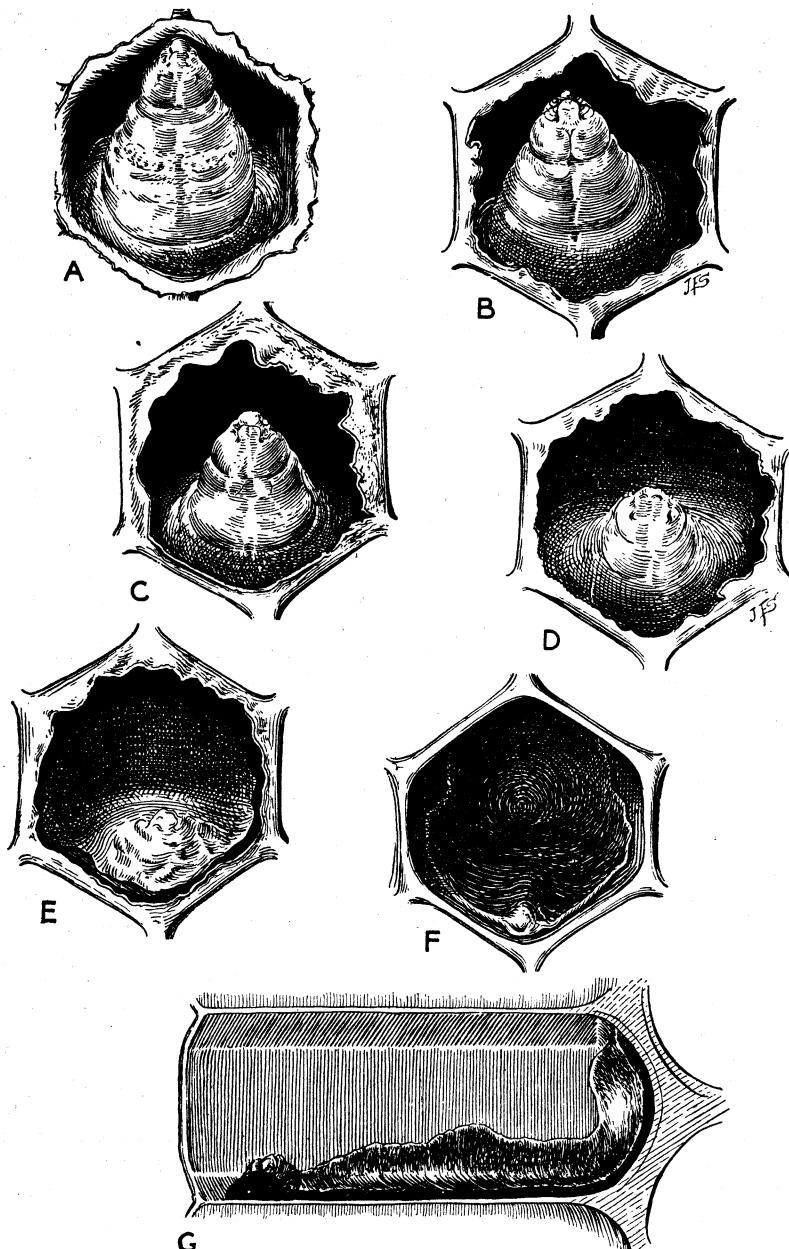


FIGURE 1.—Stages in the decomposition of larvae (prepupae) dead of American foulbrood: *A*, Healthy larva at the age when most of the brood dies of American foulbrood. *B*, *C*, *D*, *E*, Progressive stages in the decomposition of dead larvae. These stages can usually be detected only by removing the cappings. *F*, Scale of American foulbrood. Except in new combs the scale is difficult to see by looking straight into the cell. The comb should be held so that the line of sight falls on the long floor of the cells. This can be done by grasping the comb by the top bar and holding it 8 or 10 inches below the eyes and tipping the bottom bar slightly away from you. *G*, Longitudinal view of an American foulbrood scale.

has been mistaken for some of the less serious brood diseases, which require different treatment. It is therefore of the utmost importance that a correct diagnosis be made before corrective measures are applied. For this reason brief descriptions are here given of the

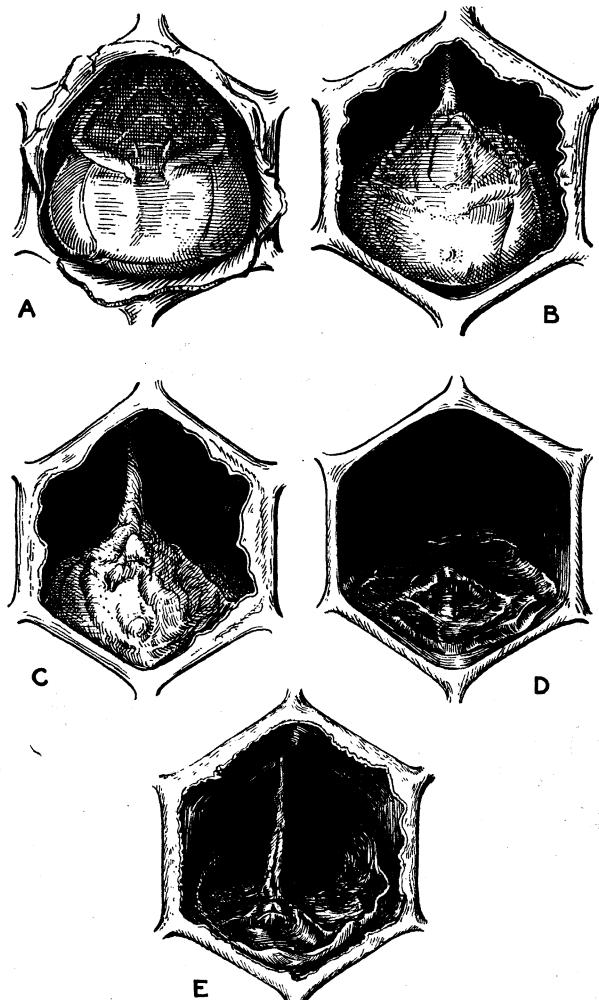


FIGURE 2.—Stages in the decomposition of pupae dead of American foulbrood: *A*, *B*, *C*, Heads of pupae showing progressive stages of melting down and decay. In *B* and *C* the tongues show prominently. *D*, Scale of American foulbrood formed from the drying down of a diseased pupa. *E*, Scale of American foulbrood formed from the drying down of a diseased pupa, with a vestige of the tongue adhering to the roof of the cell.

two other common brood disease of the apiary, European foulbrood and sacbrood.

European foulbrood usually kills the larvae in the coiled stages (fig. 3). The dead larvae are slightly yellowish white in color. The brood remains are watery, pastelike, or granular, the appearance varying according to the age at which the larvae die. The scales

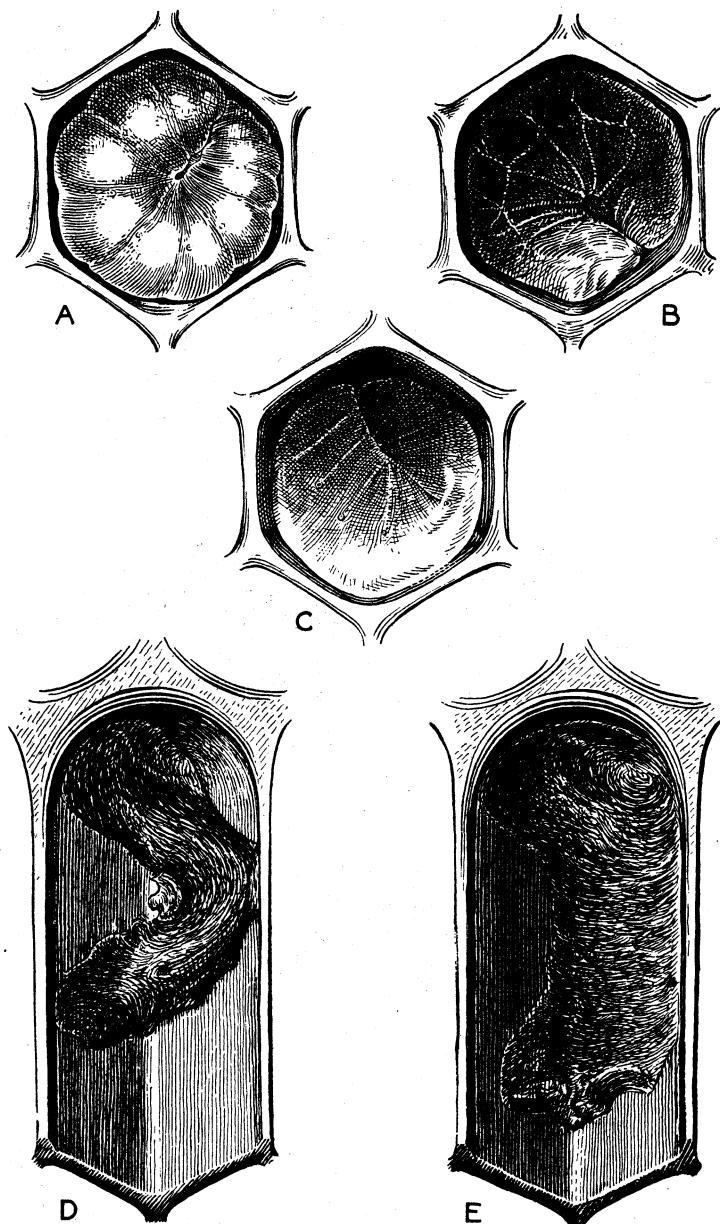


FIGURE 3.—Coiled and unsealed larvae sick or dead of European foulbrood: *A*, Healthy coiled larva at the earliest stage at which larvae die of European foulbrood; *B*, scale formed by a dried-down larva; *C*, one of several positions assumed by a sick larva prior to death; *D*, *E*, longitudinal views of scales formed from larvae that had assumed a nearly lengthwise position at the time of death, quite different from the scale shown in *B*.

do not adhere tightly to the cells and are removed by the bees in a strong colony. Occasionally larvae dead of European foulbrood become brown and ropy and present other symptoms similar to those

dead of American foulbrood (fig. 4). In such cases a correct diagnosis can usually be made only after a microscopic examination.

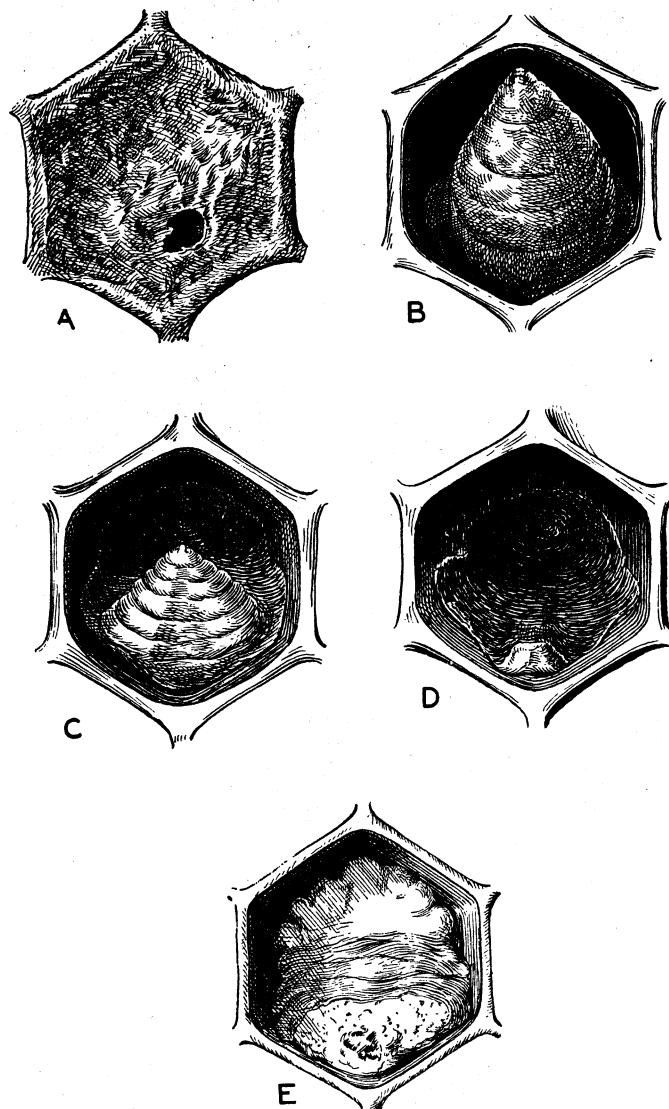


FIGURE 4.—Larvae (prepupae) which may or may not be in sealed cells and which are lying lengthwise at the time of death from European foulbrood. Stages similar in appearance to those illustrated here are encountered in American foulbrood. *A*, Sunken and perforated capping of a cell containing a larva dead of European foulbrood; *B*, larva lying lengthwise in the cell and recently dead of European foulbrood; *C*, same as *B* except in a more advanced stage of decomposition; *D*, scale formed by dried-down larva dead of European foulbrood; *E*, the remains of a larva dead of European foulbrood, part of which has been removed by the bees.

Sacbrood kills the larvae while they are extended in the cell (fig. 5), and the cappings become sunken and perforated, as in American foulbrood. The dead larvae are yellowish at first, but become

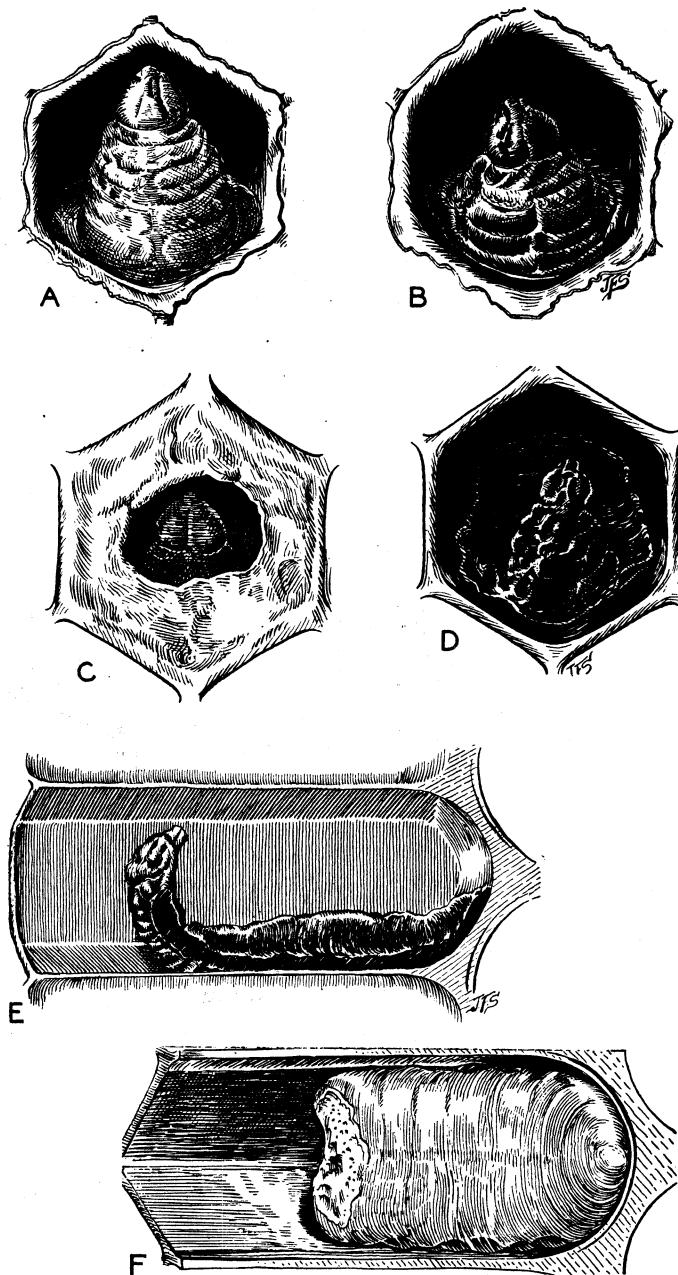


FIGURE 5.—Appearance of larvae (prepupae) dead of sacbrood: *A, B*, Stages in the course of the disease; *C*, the erect head end of a dead larva showing through an opening that the bees have made in the capping; *D, E*, two views showing the scale of sacbrood; *F*, the head portion of this larva has been gnawed away by the bees. Note how the head remains erect in all stages.

brown or black as decay advances. The heads remain erect during the process of decay. The larval skin becomes tough and saclike, thus giving the disease its name, and the material inside is watery and granular. The brood remains do not adhere to the cells; therefore, the bees are able to remove them and the disease does little damage.

#### TREATMENT

##### BURNING DISEASED COLONIES

It is now commonly recognized that the safest, and in the end the most economical, means of stamping out American foulbrood is to burn the diseased colonies. While this procedure may seem wasteful to those who believe that less drastic measures afford ample protection, it is the only method that leaves no opportunity for the disease to recur, thus relieving the mind of the bee-keeper.

Diseased colonies should be burned as soon as possible after the infection is discovered. Before this is done, however, the bees must be killed. A tablespoonful of calcium cyanide, an extremely poisonous chemical which must be handled with great care, spread on a sheet of paper or cardboard and slipped into the entrance of the hive (fig. 6), which should be left open, will kill the bees in a few minutes. As

as an extra precaution additional cyanide may be thrown into the top of the hive, since occasionally the bees fall onto the poison placed in the entrance so rapidly as to prevent the fumes from penetrating all parts of the hive. All field bees that try to gain entrance to the hive will also be killed.

Gasoline is sometimes used to kill the bees. In such cases the entrance to the hive is closed, a pint or more of gasoline is then poured over the top frames, and the hive is closed tightly.

After the bees have been killed, the contents of the hive should be burned with the least possible delay in order to avoid trouble

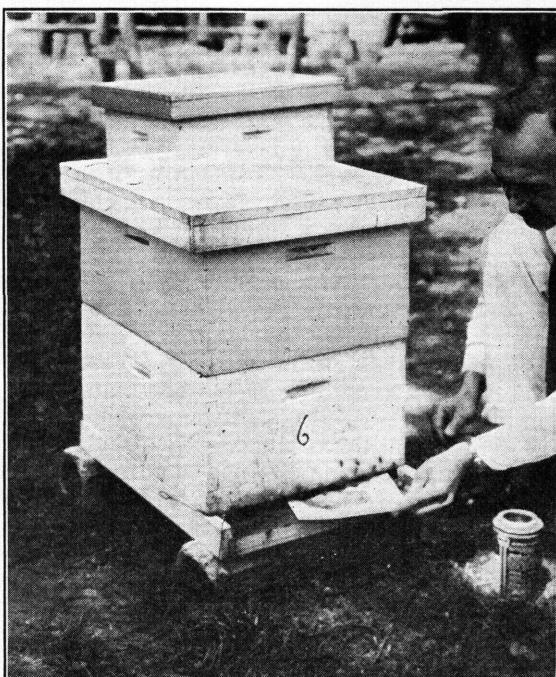


FIGURE 6.—Killing the bees of a diseased colony with calcium cyanide.

from robber bees, as both calcium cyanide and gasoline act as repellents for only a short time.

Before the bees are killed, a pit 18 inches or more deep, and wide enough to hold all the material to be burned, should be dug in a place not likely to be plowed or otherwise disturbed. A hot fire should then be kindled, with plenty of scrap material and with cross members stout enough to support the weight of the frames and placed so as to permit plenty of ventilation underneath. A brisk hot fire is necessary thoroughly to burn the brood and honey.

The hives containing the dead bees should be carried intact close to the pit and the bees and frames fed to the fire as fast as circumstances permit. The bottom board, hive bodies, inner covers, and tops are not burned. By placing the hives on pieces of burlap or stout paper it will be easy to gather up and burn the bits of comb honey or dead bees which may be dropped during the operation. After everything has been completely burned, the topsoil surrounding the fire should be raked into the pit to prevent bees from healthy colonies from having access to any dead bees or honey. The pit should then be filled.

If the killing of the bees and the burning are done at night, the danger of interference from robber bees will be lessened. It is essential, of course, to have everything well planned and all necessary material at hand.

No beekeeper should wait for an inspector to discover and burn his infected colonies, but should, himself, periodically inspect all colonies and promptly destroy every diseased one.

It should be understood that the burning of all diseased colonies in an apiary gets rid only of the colonies in which American foul-brood in an active form is plainly manifest. If there has been any equalization of the brood, if supers or combs have been transferred from one colony to another, or if diseased colonies have been robbed out, it is highly probable that the disease will show up later in other colonies. So even where burning is done carefully and thoroughly, it is usually at least 3 or 4 years before the disease can be stamped out of an apiary.

#### DISINFECTING EMPTY HIVES AFTER BURNING

After the burning, the hive bodies, bottom boards, inner covers, and tops should be taken into the honey house, thoroughly scraped to remove all propolis and wax, and then scrubbed, both inside and out, with a hot soap or lye solution and a stiff brush. The scrapings should be burned and the wash water disposed of in such a manner that it is not accessible to the bees.

Washing with soap and water is also the best way to remove spores from the hands, clothing, tools, and extracting equipment. Disinfectants strong enough to kill the spores are injurious to the hands.

If it is not feasible to wash the hive bodies, they may be stacked 7 or 8 high to form a chimney, the inside walls sprinkled with kerosene, and ignited. A little ventilation and fuel at the bottom of the stack will produce a hotter fire. Gasoline can also be used for this operation, but extreme precaution is necessary. As soon as the inside is scorched, the fire should be smothered by placing a board

over the top super. The outside of the hive bodies should then be thoroughly washed to remove all traces of honey. A gasoline blow-torch is a handy tool for scorching, but its use is rather slow.

#### SHAKING NOT RECOMMENDED

For many years the Department of Agriculture recommended the treating of infected colonies by the shaking method, whereby the bees in a diseased colony are shaken from the old combs into a clean hive on clean frames. This procedure reduces the losses due to the disease, and a careful operator, who thoroughly understands the disease, may be able to maintain his apiaries in this way. The disease is rarely eradicated by this method, however, and it usually has to be adopted as a routine manipulation. Treated colonies have to be nursed along, and the very act of shaking, if not done with meticulous care, is apt to spread the disease. Moreover, there is always a doubt as to whether the shaking is successful. A treated colony or a colony on disinfected combs cannot be pronounced clean for 2 years. Now, after many years during which colonies have been shaken to get rid of the disease and at the same time save as much as possible in the way of bees and equipment, the disease situation in the United States has not materially improved.

#### OBJECTIONS TO THE USE OF DISINFECTING SOLUTIONS

Disinfecting solutions are of only limited value in the treatment of American foulbrood. In the first place, their use for treating brood combs does not obviate the shaking treatment, as the bees must be removed before the combs are disinfected. Moreover, the careless handling of combs during the disinfecting operation may result in failure. When disease reappears after a colony has been shaken and later placed on treated combs, it is impossible to tell whether the method of shaking was at fault, the disinfection inadequate, or the colony reinfected.

Although there are several disinfectants which, when properly used, will kill the spores of American foulbrood without destroying the comb, none has yet been found to sterilize the spores in sealed honey without destroying the comb and making the honey poisonous to bees and brood. Individual sealed cells are easily overlooked and it is probable that many, if not most, of the cells of honey in the brood chamber of a diseased colony are contaminated.

Another disadvantage in the use of disinfectants is that bees are loath to accept treated combs, and as a result the size of the honey crop is reduced.

#### DISINFECTING SUPER COMBS

Disinfectants can be used effectively in treating super combs that have never contained brood. Super combs are ordinarily used on whatever colony needs them and are not set aside for designated colonies. After all the diseased colonies in an apiary have been disposed of, it is often not possible to know whether any of the general supply of super combs have become contaminated by being used on colonies with foulbrood. Therefore, it is safest to disinfect all the super combs in an outfit in which there has been appreciable

amount of American foulbrood. This is the only use recommended for disinfecting solutions in connection with the treatment of this disease.

Super combs can be disinfected with a 20 percent formalin-water solution—that is, 20 parts of formalin<sup>1</sup> to 80 parts of water, liquid measure. The combs to be disinfected should be free of honey. They should be kept immersed in the solution at a temperature of not less than 70° F. for at least 24 hours. At lower temperatures sterilization proceeds much more slowly. In order that the solution may come in contact with all parts of the cells, after being placed in the solution the combs should be agitated to dispel as many air bubbles as possible. This can also be accomplished by pouring the solution into the tank so that it rises slowly enough to fill each cell completely.

The 20 percent formalin-water solution may be used repeatedly without much deterioration in strength. It is advisable, however, to add formalin occasionally to maintain full strength of the solution.

Formalin is unpleasant to work with, although not dangerous. It is well for the operator to protect his hands with rubber gloves.

Formalin-alcohol solution, formaldehyde gas, and chlorine also kill the spores of American foulbrood without necessarily destroying the combs. Formalin-alcohol solution, a patented article, is slightly less effective than the 20 percent formalin-water solution and is more expensive. Formaldehyde in gaseous form cannot be recommended for treating American foulbrood combs. The use of chlorine, although still in the experimental stage, has produced disappointing results and, moreover, it is extremely dangerous to handle.

#### TREATMENT BY STATE INSPECTORS

Under most conditions inspectors are justified in burning every diseased colony immediately, because such a colony constitutes a menace to all healthy colonies in the vicinity. The maintenance of such a serious nuisance as a colony containing American foulbrood should not be tolerated. The best interests of the industry demand the prompt disposal of all such colonies.

When a State inspection force is applying the area-clean-up method for the first time, however, and when the incidence of the disease is high, the use of the shaking treatment is sometimes justifiable. The advisability of using it depends not only upon the amount of disease in a particular apiary or area, but upon the character of the beekeeping, the kind of equipment employed, and the facilities and experience of the beekeepers for doing the job.

Where shaking is used in the first steps of an eradication program, the State inspectors should give every consideration to the protection of healthy colonies. The establishment of temporary yards where diseased colonies can be treated without endangering healthy colonies is strongly recommended in this connection. These temporary yards are not to be confused with hospital yards, which were recommended at one time and with which many beekeepers are

<sup>1</sup> Formalin or formaldehyde solution is an aqueous solution containing from 37 to 40 percent of formaldehyde gas.

familiar. Temporary yards are used only to shake and reestablish the bees in a place where healthy colonies are not endangered. The contents of the hives other than bees should be burned with the least possible delay.

#### HANDLING AND DISPOSING OF HONEY FROM AFFECTED COLONIES

The honey from a diseased colony, if it constitutes a super or more, may be saved and marketed. The handling of this honey, however, requires special attention. At no time should it be accessible to the bees. Therefore, since no honey house is, strictly speaking, bee-tight, the honey should be bottled or canned as soon as possible, every vestige of honey washed from the outside of containers and from the extracting equipment and honey house, and the empty combs burned. No attempt should be made to recover honey from diseased colonies unless there is a distinct economic saving.

Since it is often impossible to ascertain the source of honey purchased on the open market, such honey should not be fed to colonies of bees if it can be avoided. If such honey has to be used, it should first be diluted with an equal volume of water and boiled for an hour in a closed vessel. Boiled honey, however, should not be fed for winter stores.

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